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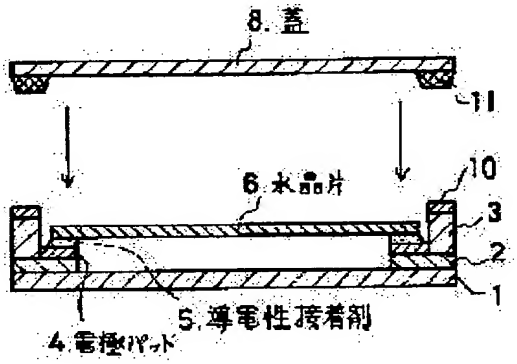
(71)Applicant : CITIZEN WATCH CO LTD
(72)Inventor : KIZAKI SHIGERU
SAKAGUCHI YASUKAZU
KIMURA HACHIRO
MURATA KAZUO
NAKAYAMA KAZUMASA
TANAKA TAKAMASA
OI SHUNEI

(54) SURFACE MOUNTED CRYSTAL RESONATOR

(57)Abstract:
PROBLEM TO BE SOLVED: To reduce the secular change of a frequency by supporting and fixing the side of both short sides of a crystal piece in a rectangular shape by the electrically conductive adhesive material of an Si group or the like, hermetically joining a cover to a terminal member by an inorganic material and forming a container whose inner part is evacuated.

SOLUTION: The crystal piece is supported and fixed on both sides, the long side direction of the crystal piece 6 is turned to a Z axis and both end side parts composed of an X axis orthogonally crossing it are supported and fixed by the electrically conductive adhesive material 5. That is, it is taken into consideration that thickness- shear vibration waves vibrated at an excitation electrode provided on the crystal piece 6 are propagated in an X axis direction and propagated little to a Z axis direction, by supporting and fixing the Z axis direction, an effect to the thickness-shear vibration is made small. Also, in the case of supporting and fixing the crystal piece 6 on one side, the crystal piece 6 is supported and fixed to electrode pad parts 4 at two parts by the electrically conductive adhesive material and the thickness-shear vibration waves are small in the Z axis direction. Thus, the frequency is stabilized by the electrically conductive adhesive material 5. Then, by evacuating the inner part of the container, the gas inside the container is reduced and the frequency is stabilized.



LEGAL STATUS

CLAIMS

[Claim(s)]

[Claim 1] It is the surface mount type quartz resonator which is a surface mount type quartz resonator which carries out support fixation of one side or the both sides of both short side parts which it has in rectangle-like the piece of crystal by the electroconductive glue of a silicon system. an urethane system. or a polyimide system. carries out airtight junction of the lid by inorganic material at terminal area material. and constitutes a container on the flat surface of terminal area material. or in a crevice. and is characterized by the inside of a container being a vacuum.

[Claim 2] It is the surface mount type quartz resonator which is a surface mount type quartz resonator which carries out support fixation of one side or the both sides of both short side parts which it has in rectangle-like the piece of crystal by the electroconductive glue of a silicon system. an urethane system. or a polyimide system. carries out airtight junction of the lid with a pewter at terminal area material. and constitutes a container on the flat surface of terminal area material. or in a crevice. and is characterized by the inside of a container being a vacuum.

[Claim 3] It is the surface mount type quartz resonator which is a surface mount type quartz resonator which carries out support fixation of one side or the both sides of both short side parts which it has in rectangle-like the piece of crystal by the electroconductive glue of a silicon system. an urethane system. or a polyimide system. carries out airtight junction of the lid with seam welding at terminal area material. and constitutes a container on the flat surface of terminal area material. or in a crevice. and is characterized by the inside of a container being a vacuum.

[Claim 4] It is the surface mount type quartz resonator which sets Z' shaft as the direction of the long side of a AT-cut rectangle-like the piece of crystal on the flat surface of terminal area material. or into a crevice. is a surface mount type quartz resonator which carries out support fixation of both the short side parts that are X shaft orientations which intersected perpendicularly at it by the electroconductive glue of a silicon system or an urethane system. carries out airtight junction of the lid with a pewter at terminal area material. and constitutes a container. and is characterized by the inside of a container

[Claim 5] It is the surface mount type quartz resonator which sets Z' shaft as the direction of the long side of the piece of AT-cut rectangle-like crystal on the flat surface of terminal area material. or into a crevice. is a surface mount type quartz resonator which carries out support fixation of both the short side parts that are X shaft orientations which intersected perpendicularly at it by the electroconductive glue of Sealy's KON system or an urethane system. carries out airtight junction of the lid with seam welding at terminal area material. and constitutes a container. and is characterized by the inside of a container being a

[Claim 6] It is the surface mount type quartz resonator which sets the X-axis as the direction of the long side of a AT-cut rectangle-like the piece of crystal on the flat surface of terminal area material. or into a crevice. is a surface mount type quartz resonator which carries out support fixation of one side of the short side part which is Z' shaft orientations which intersected perpendicularly at it by the electroconductive glue of a silicon system. an urethane system. or a polyimide system. carries out airtight junction of the lid with a pewter at terminal area material. and constitutes a container. and is characterized

[Claim 7] It is the surface mount type quartz resonator which sets the X-axis as the direction of the long side of a AT-cut rectangle-like the piece of crystal on the flat surface of terminal area material. or into a crevice. is a surface mount type quartz resonator which carries out support fixation of one side of the short side part which is Z' shaft orientations which intersected perpendicularly at it by the electroconductive glue of a silicon system. an urethane system. or a polyimide system. carries out airtight junction of the lid with seam welding at terminal area material. and constitutes a container. and is characterized by

[Claim 8] One side or the both sides of both short side parts which it has on the flat surface of terminal area material. or in a crevice at rectangle-like the piece of crystal A silicon system. Support fixation is carried out by the electroconductive glue of an urethane system or a polyimide system. The configuration of the electrode pad section of the piece support fixed part of crystal which it has in terminal area material is a surface mount type quartz resonator which prepares a square shape or the circular non-pad section in electrode pad circles. or has a square shape or the circular non-pad section at the edge of the electrode pad section. An electroconductive glue is a surface mount type quartz resonator characterized by preparing the both sides of the electrode pad section and the non-pad section.

[Claim 9] One side or the both sides of both short side parts which it has on the flat surface of terminal area material. or in a crevice at rectangle-like the piece of crystal A silicon system. Support fixation is carried out by the electroconductive glue of an urethane system or a polyimide system. The configuration of the electrode pad section of the piece support fixed part of crystal which it has in terminal area material is a surface mount type quartz resonator which has a square shape or a circular non-pad at the edge of the electrode pad section or it prepares a square shape or a circular non-pad in electrode pad circles. An electroconductive glue is the claims 1, 2, 3, 4, 5, and 6 characterized by the thing which prepare the both sides of the electrode pad section and the non-pad section, and to do, or a surface mount type quartz resonator given in seven.

[Claim 10] One side or the both sides of both short side parts which it has on the flat surface of terminal area material. or in a crevice at rectangle-like the piece of crystal A silicon system. The configuration of the edge

electrode of the piece of rectangle-like crystal which carries out support fixation by the electroconductive glue of an urethane system and a polyimide system and which is fixed to the electrode pad section of terminal area material It is the surface mount type quartz resonator characterized by the thing which are the surface mount type quartz resonators which prepare a square shape or the circular non-polar zone in the edge of an edge electrode or it prepares a square shape or the circular non-polar zone in an edge electrode, and prepares the both sides of an edge electrode and the non-polar zone an electroconductive glue, and to do.

[Claim 11] One side or the both sides of both short side parts which it has on the flat surface of terminal area material, or in a crevice at rectangle-like the piece of crystal The configuration of the edge electrode of the piece of rectangle-like crystal which carries out support fixation by the electroconductive glue of a silicon system, an urethane system, or a polyimide system and which is fixed to the electrode pad section of terminal area material It is the surface mount type quartz resonator which prepares a square shape or the circular non-polar zone in the edge of an edge electrode or it prepares a square shape or the circular non-polar zone in an edge electrode. An electroconductive glue is the claims 1, 2, 3, 4, 5, 6, and 7 characterized by the thing which prepare the both sides of an edge electrode and the non-polar zone, and to do, or a surface mount type quartz resonator given in eight.

[Claim 12] The quality of the material of the terminal area material which constitutes a container is ceramics, a crystallized glass, the claims 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 that are characterized by the bird clapper from glass, or a surface mount type quartz resonator given in 11.

[Claim 13] The quality of the material of the lid which constitutes a container is ceramics, a crystallized glass, glass, the claims 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 that are characterized by the bird clapper from a metal, or a surface mount type quartz resonator given in 11.

[Claim 14] The plating material which the quality of the material of the lid which constitutes a container consists of a metal, and is formed on a metal is the claims 1, 2, 3, 4, 5, 6, 7, 8, 9, and 10 characterized by the bird clapper from gold, palladium, or nickel and palladium, or a surface mount type quartz resonator given in 11.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[The technical field to which invention belongs] About the structure of the quartz resonator which needs this invention for the frequency reference standard of mobile communication equipment especially a cellular phone, or a pager, in more detail, in-series equivalent resistance is low, and it excels in the long term stability of oscillation frequency, reflow-proof nature, and shock resistance, and is related with the highly precise surface mount type quartz resonator which moreover makes structure of small and a thin shape possible.

[0002]

[Description of the Prior Art] A highly precise temperature compensated crystal oscillator (it is indicated as Following TCXO) is used for the frequency reference standard for mobile communication equipment, such as a cellular phone. TCXO is also calculated for small and a thin shape, and the surface mount type that has reflow-proof nature further from small and the thin shape of mobile communication equipment in recent years. Therefore, after it is satisfied [with the quartz resonator which is the main parts of TCXO] of a property attaining them, moreover, a surface mount type quartz resonator is needed with small and a thin shape.

[0003] The thickness-slip-vibration child of a AT cut is used for the quartz resonator for TCXO. And the vibrator property searched for has the small frequency deviation of ordinary temperature, the temperature characteristic of frequency is excellent in a continuity, and the rate of change of the frequency in ordinary temperature neglect, elevated-temperature neglect, cold resistance, **-proof, a temperature cycle, vibration, fall, and a reflow-proof examination is less than [plus-or-minus 1ppm] further.

[0004] Thus, process conditions need a package, selection of a closure means, crystallographic-axis selection of the piece of crystal, the suitable design of the piece size of crystal, an electrode material, the design of a suitable electrode configuration, the piece manner of support of crystal, and to be built to satisfy a severe property and attain a surface mount type quartz resonator moreover.

[0005] The structure of the surface mount type quartz resonator in the conventional technology is explained using drawing 15 , drawing 16 , drawing 18 , and drawing 19 . Drawing 16 is a cross section in which the hermetic seal in the conventional technology shows the surface mount type quartz resonator using the seam welding means.

[0006] As shown in drawing 16 , the 1st substrate 1, 2nd substrate 2, and 3rd substrate 3 constitute an alumina from a multilayer ceramic substrate made into a principal component. The electrode pad section 4 on the 2nd substrate 2 calcinated a tungsten or molybdenum, performed nickel plating on it, and has plated with gold on this nickel plating further. Support fixation of the piece 6 of crystal is carried out at one side by the electroconductive glue 5, and electrical installation is performed in this electrode pad section 4 simultaneously with support fixation.

[0007] The seam ring 7 which becomes the 3rd substrate 3 from a covar alloy is carrying out silver low attachment, performed nickel plating, and has plated with gold on this nickel plating further. Furthermore, the

welding electrode 9 of a parallel seam welding machine performs a hermetic seal for the lid 8 which nickel plating gave on it at the covar alloy, and atmosphere in the container is used as the low nitrogen of a dew-point.
[0008] A pressure is atmospheric pressure although this surface mount type quartz resonator makes the inside of a container nitrogen atmosphere in order to press down the secular change of frequency low. For this reason, the crystal impedance of a quartz resonator is 13ohms - about 15ohms. Since the hermetic seal by this parallel seam welding is low-temperature junction, it does not have the heat-resistant problem of an electroconductive glue 5, and the width of face of selection has a latus advantage.
[0009]
[Problem(s) to be Solved by the Invention] However, there are the following troubles in the conventional surface mount type quartz resonator mentioned above. Drawing 18 is a graph which shows the secular change of the frequency in the surface mount type quartz resonator which carried out the hermetic seal with parallel seam welding in nitrogen atmosphere. A horizontal axis is the days which measured frequency from immediately after the hermetic seal, and a vertical axis is the rate of change of frequency. The frequency rate of change for [it asks] one year is less than [plus-or-minus 1ppm].
[0010] Although Curve D goes into the specification whose frequency rate of change is the above-mentioned plus-or-minus 1ppm, what frequency shifts to plus or minus with change of time like Curve A and Curve B occurs. Thus, the early judging of a quality is difficult at the time of shipment, and it cannot continue at a long period of time, and measurement cannot carry out total, either, but the product which time requires for stabilization of frequency, consequently separates from specification has the problem which appears on the market in a commercial scene.
[0011] The trouble of the surface mount type quartz resonator in the conventional technology is further explained below using the plan of drawing 15 , and the graph of drawing 19 . Drawing 15 is a plan about the state where the electroconductive glue 5 in a surface mount type quartz resonator was formed. An electroconductive glue 5 is formed as an object for support fixation of the piece 6 of crystal on the electrode pad section 4. Since the piece 6 of crystal is support fixation of one side, it makes the field of the electrode pad section 4 2 terminal structures.
[0012] The drop test result of the surface mount type quartz resonator using this means is explained using the graph of drawing 19 . Natural fall of the drop test conditions is carried out from a height of 1.5m on concrete, a horizontal axis shows the number of times of fall, and a vertical axis shows the rate of change of frequency. The specification of a surface mount type quartz resonator is less than [plus-or-minus 1ppm] as mentioned above. It is as a result of [of the surface mount type quartz resonator which bar graph F shown by hatching explained using drawing 15 and drawing 16] a drop test.
[0013] As the graph of drawing 19 shows, the rate of change of frequency has secured less than [plus-or-minus 1ppm] to ten drop tests. However, in 20 drop tests, plus-or-minus 1ppm will be exceeded greatly. This cause is explained using drawing 15 . Gilding is given to the electrode pad section 4 and the electroconductive glue 5 of a silicon system is formed on it. However, the adhesion force of the silicon which is an electroconductive glue 5, and the gold of the electrode putt section 4 is a low. By 20 drop tests, an ablation phenomenon arises from this in both interface.
[0014] Then, the purpose of this invention is to solve the above-mentioned technical problem and offer the surface mount type quartz resonator which attained early stabilization of the secular change of frequency, and certain-ization of the quality judging by it. It aims at furthermore offering the surface mount type quartz resonator in eye in addition of the above-mentioned invention which can attain reduction-ization of the frequency rate of change in a drop test.
[0015]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, the composition of the following publication is adopted in the surface mount type quartz resonator of this invention.
[0016] In the surface mount type quartz resonator of this invention, it is the surface mount type quartz resonator which carries out support fixation of one side or the both sides of both short side parts which it has on the flat surface of terminal area material, or in a crevice at rectangle-like the piece of crystal by the electroconductive glue of a silicon system, an urethane system, or a polyimide system, carries out airtight junction of the lid by inorganic material at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0017] It is the surface mount type quartz resonator which the surface mount type quartz resonator of this invention carries out support fixation of one side or the both sides of both short side parts which it has on the flat surface of terminal area material, or in a crevice at rectangle-like the piece of crystal by the electroconductive glue of a silicon system, an urethane system, or a polyimide system, carries out airtight junction of the lid with a pewter at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0018] In the surface mount type quartz resonator of this invention, it is the surface mount type quartz resonator which carries out support fixation of one side or the both sides of both short side parts which it has on the flat surface of terminal area material, or in a crevice at rectangle-like the piece of crystal by the electroconductive glue of a silicon system, an urethane system, or a polyimide system, carries out airtight junction of the lid with seam welding at terminal area material, and constitutes a container, and is

characterized by the inside of a container being a vacuum.
[0019] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice Both the short side parts that are X shaft orientations which set Z' shaft as the direction of the long side of a AT-cut rectangle-like the piece of crystal, and intersected perpendicularly with it A silicon system, Or it is the surface mount type quartz resonator which carries out support fixation by the electroconductive glue of an urethane system, carries out airtight junction of the lid with a pewter at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0020] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice Both the short side parts that are X shaft orientations which set Z' shaft as the direction of the long side of a AT-cut rectangle-like the piece of crystal, and intersected perpendicularly with it A silicon system, Or it is the surface mount type quartz resonator which carries out support fixation by the electroconductive glue of an urethane system, carries out airtight junction of the lid with seam welding at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0021] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice One side of the short side part which is Z' shaft orientations which set the X-axis as the direction of the long side of a AT-cut rectangle-like the piece of crystal, and intersected perpendicularly with it A silicon system, It is the surface mount type quartz resonator which carries out support fixation by the electroconductive glue of an urethane system or a polyimide system, carries out airtight junction of the lid with a pewter at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0022] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice One side of the short side part which is Z' shaft orientations which set the X-axis as the direction of the long side of a AT-cut rectangle-like the piece of crystal, and intersected perpendicularly with it A silicon system, It is the surface mount type quartz resonator which carries out support fixation by the electroconductive glue of an urethane system or a polyimide system, carries out airtight junction of the lid with seam welding at terminal area material, and constitutes a container, and is characterized by the inside of a container being a vacuum.
[0023] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice One side or the both sides of both short side parts which it has in rectangle-like the piece of crystal A silicon system, Support fixation is carried out by the electroconductive glue of an urethane system or a polyimide system. The configuration of the electrode pad section of the piece support fixed part of crystal which it has in terminal area material is a surface mount type quartz resonator which prepares a square shape or the circular non-pad section in electrode pad circles, or has a square shape or the circular non-pad section at the edge of the electrode pad section. It is characterized by preparing the both sides of the electrode pad section and the non-pad section an electroconductive glue.
[0024] In the surface mount type quartz resonator of this invention on the flat surface of terminal area material or in a crevice One side or the both sides of both short side parts which it has in rectangle-like the piece of crystal A silicon system, The configuration of the edge electrode of the piece of rectangle-like crystal which carries out support fixation by the electroconductive glue of an urethane system and a polyimide system and which is fixed to the electrode pad section of terminal area material It is the surface mount type quartz resonator which prepares a square shape or the circular non-polar zone in an edge electrode, or prepares a square shape or the circular non-polar zone in the edge of an edge electrode, and an electroconductive glue is characterized by the thing which prepare the both sides of an edge electrode and the non-polar zone and to do.
[0025] In the surface mount type quartz resonator of this invention, the quality of the material of the terminal area material which constitutes a container is characterized by the bird clapper from ceramics, a crystallized glass, or glass.
[0026] In the surface mount type quartz resonator of this invention, the quality of the material of the lid which constitutes a container is characterized by the bird clapper from ceramics, a crystallized glass, glass, or a metal.
[0027] In the surface mount type quartz resonator of this invention, the quality of the material of the lid which constitutes a container consists of a metal, and plating material formed on a metal is characterized by the bird clapper from gold, palladium, or nickel and palladium.
[0028] Thus, the above-mentioned composition is used for the surface mount type quartz resonator of this invention, and this invention is improving the trouble of the conventional technology from the following view. That is, to the purpose of early stabilization of frequency, and certain-izing of a quality judging, a main solution means attains early stabilization and certain-ization of a quality judging by adopting a vacuum lock from the composition which carries out airtight junction in the nitrogen atmosphere of the atmospheric pressure which is the conventional technology.
[0029] That is, when it is atmospheric pressure, even if it performs airtight junction in nitrogen atmosphere, the gas which occurs at the time of seam welding is full in a container, and stabilization of atmosphere takes time. Furthermore, stabilization of frequency is spoiled when the particle of the metal which disperses at the time of seam welding adheres to the piece of crystal in the unstable state. I think that stabilization of the frequency after airtight junction takes time the result compound [their].
[0030] In the case of a vacuum lock, by this invention, stabilization of frequency is realizable ~~to~~ it early after

airtight junction. That is, I think that the occurring gas by airtight junction has [be / under / vacuum / sake / it] the high rate discharged out of a container. For this reason, the atmosphere in a container is stable at an early stage. Consequently, in the surface mount type quartz resonator of this invention, stabilization of frequency will be early. The point that stabilization of this frequency is early brings about the effect which can perform the quality judging at the time of shipment for a short time.

[0031] Since it is furthermore a point over certain-izing of a quality judging and seam welding is airtight junction by atmospheric pressure, the crystal impedances of a quartz resonator are 13-15ohm. However, although a crystal impedance does not change even if there is very small leak, frequency is shifted after prolonged progress. That is, it is because the atmosphere requires time and permeates in a container. Then, although a leak examination is carried out by the helium leak tester at the time of shipment, the very small leak which influences aging of frequency has an undetectable problem.

[0032] However, according to the vacuum lock of this invention, a crystal impedance becomes low with 5-7ohm. In this case, if there is very small leak, since the crystal impedance is sensitive to container internal pressure, it will increase immediately. For this reason, by judging the augend, the existence of leak can be judged, consequently the shift of the frequency after prolonged progress can be judged at an early stage with the surface mount type quartz resonator of this invention.

[0033] On the other hand, although support fixation of the piece of crystal is directly carried out by reduction-ization of the frequency rate of change in a drop test at terminal area material since it is a thin surface mount type quartz resonator, the method of support fixation has two kinds, one side of the piece of crystal, and both sides. In this invention, in the case of both sides, the silicon system electroconductive glue which is elasticity is used, and the frequency shift by the fall shock is reduced. That is, in the surface mount type quartz resonator of this invention, the mechanical stress by the fall shock is eased using what has elasticity in an electroconductive glue. The elasticity of an electroconductive glue is still more effective also in aging of the effect which eases the mechanical stress which joins the piece of crystal to frequency.

[0034] However, the silicon system adhesives of elasticity cannot be said that the adhesion force of the electrode pad section which it has in terminal area material, and the gold of the edge electrode which it has in the piece of crystal is high, either. For this reason, with a strong fall shock, there is a problem from which an ablation phenomenon arises in both interface, and frequency changes.

[0035] However, the electroconductive glue of a silicon system is checking the phenomenon in which the ceramics and crystal of terminal area material have the strong adhesion force. Then, this invention makes the electrode pad section of terminal area material also expose ceramics to a front face, and exposes crystal to the edge electrode of the piece of crystal further. By this, by pasting the both sides of not only gold but ceramics, and crystal, a silicon system electroconductive glue raises the support fixed force of the piece of crystal, and reduces the rate of change of the frequency by the fall shock by this invention.

[0036]

[Embodiments of the Invention] The surface mount type quartz resonator in the best gestalt for carrying out this invention using a drawing below is explained. Drawing 1 is the cross section showing the state before carrying out support fixation of the piece of crystal in the operation gestalt of this invention on both sides and carrying out airtight junction of the lid. Drawing 2 is the cross section showing the state where carried out support fixation of one side in the operation gestalt of this invention, and airtight junction of the lid was carried out. Drawing 3 is the plan showing the state before carrying out airtight junction of the lid in drawing 1 of this invention. Drawing 4 is the plan showing the crystallographic axis of the piece of crystal in this invention. Drawing 5 , drawing 6 , drawing 7 , drawing 8 , drawing 9 , and drawing 10 are the plans showing the various electrode pad section configurations of the insulating terminal area material in the operation gestalt of this invention. Furthermore, drawing 11 , drawing 12 , and drawing 13 are the plans showing the various edge electrode configurations of the piece of crystal in the operation gestalt of this invention. Drawing 14 is the cross section showing the structure which carried out support fixation by the electroconductive glue combining the insulating terminal area material and the piece of crystal which used this invention. Drawing 17 is the cross section showing the lid in the operation gestalt of this invention. Drawing 20 is the cross section showing a crystal oscillator. Although explained using the drawing in which the operation gestalt of this invention is shown below, it explains with reference to the drawing in which the conventional technology is shown suitably.

[0037] As shown in drawing 1 and drawing 3 , the 1st substrate 1, 2nd substrate 2, and 3rd substrate 3 constitute terminal area material. And the piece 6 of crystal is carrying out support fixation at the both ends at terminal area material. A tungsten or molybdenum was calcinated for the electrode pad section 4 and the hermetic-seal section 10 to the terminal area material which consists of a multilayer ceramic substrate of the 1st substrate 1, the 2nd substrate 2, and the 3rd substrate 3, and on the tungsten or molybdenum, nickel plating was performed and it has plated with gold further.

[0038] Although the ceramics made into the principal component explain an alumina to terminal area material with the operation gestalt of this invention, you may apply a crystallized glass and glass. In the case of the terminal area material which consists of a crystallized glass, the mixture of silver or silver, and palladium is used for the quality of the material of the electrode pad section 4 and the hermetic-seal section 10.

[0039] Hereafter, although explanation with the gestalt of this invention explains terminal area material by the three-layer substrate, a substrate is much more sufficient as it also at the bilayer substrate-which deleted the

2nd substrate 2. The electroconductive glue 5 of a silicon system is formed in the electrode pad section 4 shown in drawing 1 , and the piece 6 of crystal is installed on it. The adhesives of an urethane system are sufficient as an electroconductive glue 5. That is, it is easy to be the adhesives of elasticity.

[0040] A pewter 11 is formed in the lid 8 shown in drawing 1 . The detailed structure is explained using the cross section of drawing 17 . The base material 12 of the lid shown in drawing 17 consists of covar or an iron nickel alloy, and adopts the two-layer structure of a nickel coat and a golden coat, the two-layer structure of a nickel coat and a palladium coat, or the two-layer structure of a nickel coat and a nickel palladium coat as a surface treatment film 13 on the covar and iron nickel alloy.

[0041] This nickel coat has a role on an anti-corrosion disposition, and a golden coat and a palladium coat have the role which raises wettability with a pewter 11. Among these, the reason using palladium is that there is no meal crack phenomenon by the pewter 11, and there is the feature with little airtight leak. Moreover, the quality of the material of a pewter 11 uses alloys, such as golden (Au)-tin (Sn), lead (Pb)-(silver Ag)-tin (Sn), and lead (Pb)-tin (Sn). In addition to the above, if it is the low-temperature material in which a hermetic seal is possible, it is applicable as a pewter 11.

[0042] Although the metallic material furthermore explained as the quality of the material of a lid 8, ceramics, a crystallized glass, and glass are also applicable. Terminal area material and a lid 8 have a desirable combination which the coefficient of thermal expansion adjusts.

[0043] In drawing 1 , the pewter 11 of a lid 8 is hermetic-seal welded [which is formed in the 3rd substrate 3 / 10] in a vacuum. If a pewter 11 is golden (Au)-tin (Sn), welding temperature is before and after 300 degrees C, and welding time is several minutes. Moreover, welding work is done in the heater substrate which can be processed.

[0044] Although the operation gestalt shown in drawing 2 is the almost same composition as the structure shown in drawing 1 , it performs support fixation of the piece 6 of crystal at one side. The electrode pad section 4 which it has in the terminal area material of the single-sided support uses one side as two terminals, as shown in drawing 9 . Furthermore, although a silicon system is sufficient as an electroconductive glue 5, a polyimide system is sufficient as it. By having made support fixation of the piece 6 of crystal into one side, in order to heighten the support fixed force, the stiff quality of the material is used a little from a silicon system.

[0045] The graph which shows the secular change of the frequency of the surface mount type quartz resonator in the gestalt of this invention explained using drawing 1 , drawing 2 , and drawing 3 to drawing 18 explains. A horizontal axis is the days which measured frequency from immediately after the hermetic seal, and a vertical axis is the rate of change of frequency. The frequency rate of change for [it asks] one year is less than [plus-or-minus 1ppm].

[0046] Although stabilization of frequency had taken the surface mount type quartz resonator which carried out the hermetic seal in the nitrogen atmosphere of atmospheric pressure with the conventional seam welding to time as shown in Curve A, Curve B, and Curve D, as shown in Curve C, while frequency of the surface mount type quartz resonator by this invention is stable at an early stage, the rate of change of the frequency in a long period of time is small. Furthermore, a defective deteriorates greatly for a short period of time, as shown in Curve E. That is, compared with the conventional atmospheric pressure closure, a quality clarifies within a short period of time. For this reason, a quality judging can be made early at the time of shipment.

[0047] The surface mount type quartz resonator by the operation gestalt of this invention makes small the rate of change of the frequency in early stabilization and the long period of time of frequency from the following combination. That is, the generating gas at the time of a hermetic seal is lessened by making the inside of a container into a vacuum. Moreover, as shown in drawing 2 and drawing 3 , when support fixation of the piece 6 of crystal is carried out on both sides, the mechanical stress which joins the piece 6 of crystal using the electroconductive glue 5 of the silicon system of elasticity is made to ease. It is because coefficients of thermal expansion differ with the ceramics of the piece 6 of crystal, and terminal area material.

[0048] As furthermore shown in drawing 4 , with the operation gestalt which carries out support fixation of the piece 6 of crystal on both sides, Z'shaft is set as the direction of the long side of the piece 6 of crystal, and support fixation of both the end parts 15 that consist of the X-axis which intersects perpendicularly with it is carried out by the electroconductive glue 5. That is, the oscillatory wave of the thickness slip vibration which vibrates by the excitation electrode 14 prepared in the piece 6 of crystal is spread to X shaft orientations, and the propagation to Z'shaft is the point which made influence on thickness slip vibration small by carrying out support fixation of the Z'shaft orientations in consideration of a small point.

[0049] On the other hand, when carrying out support fixation of the piece 6 of crystal at one side conversely indicated to be the above-mentioned to drawing 2 , the crystallographic axis shown in drawing 4 is made reverse. That is, the X-axis is set as the direction of the long side, and a short side part is made into Z'. Although support fixation of the piece 6 of crystal is carried out by the electroconductive glue 5 at the two electrode pad sections 4 as it becomes two terminals in single-sided support and is shown in drawing 9 , the oscillatory wave of thickness slip vibration is because it is small to Z'shaft orientations like ****. Therefore, the stiff electroconductive glue 5 can attain stabilization of frequency similarly a little from a silicon system like a polyimide system.

[0050] although pewter closure has explained the gestalt of the operation in this invention, even if it is the seam welding method of the conventional technology shown in drawing 16 , it is a vacuum lock, and if the

combination which took into consideration the crystal orientation whose support moment distribution method is a piece of crystal, using the electroconductive glue of elasticity is used, the same effect as what was explained by this invention will be acquired If airtight junction is carried out, carrying out evacuation although gas also generates a seam welding method by the spark at the time of welding, there is little gas in a container and it can attain stabilization of frequency.

[0051] The gestalt of the operation of this invention to reduction-izing of the frequency rate of change by the drop test is explained below using a drawing. In drawing 1 . an electroconductive glue 5 is formed in the electrode pad section 4, and although support fixation of the piece 6 of crystal is carried out. the configuration of the electrode pad section 4 in this invention is explained one by one. Drawing 5 shows the operation gestalt which forms two or more non-pad sections 16 which have a square shape alternately with right and left in the edge of the electrode pad section 4 on the 2nd substrate 2. In drawing 5 , although the square shape is used, it may be circular. An electroconductive glue 5 is prepared for the both sides of the electrode pad section 4 and the non-pad section 16.

[0052] Drawing 6 shows a single ******** operation gestalt for the non-pad section 16 which has a square shape at the edge of the electrode pad section 4. The non-pad section 16 is the same ceramics as the 2nd substrate 2. Although it has the non-pad section 16 on the right-hand side of terminal area material. left-hand side is sufficient. Also in the operation gestalt shown in this drawing 6 . an electroconductive glue 5 prepares the both sides of the electrode pad section 4 and the non-pad section 16.

[0053] Drawing 7 shows the operation gestalt which forms the square shape-like non-pad section 16 in the interior of the electrode pad section 4. In addition to the shape of a square shape, a circle configuration etc. is sufficient as the non-pad section 16, and they may be prepared. [two or more] Drawing 8 shows the operation gestalt which forms two or more non-pad sections 16 which have the shape of a triangle in the edge of the electrode pad section 4, and drawing 9 shows the operation gestalt which forms two or more non-pad sections 16 which have a circle configuration. Although the gestalt of operation of this invention has indicated that it is circular, you may be a semicircle in this way and what has curvature further can be applied. Moreover, although two or more same configurations are established, the combination of a different-species configuration is sufficient. An electroconductive glue 5 continues and prepares the both sides of the electrode pad section 4 and the non-pad section 16 all. And as for the area rate of the electrode pad section 4 and the non-pad section 16 about 1 to 1 is desirable.

[0054] Drawing 10 shows the operation gestalt of the electrode pad section configuration in the case of carrying out support fixation of the piece 6 of crystal as shown in drawing 2 at one side. Since the electrode of the piece 6 of crystal in the case of carrying out support fixation at one side serves as two terminals at one side, the electrode pad section has also prepared two terminals in one side. The non-pad section 16 which consists of a circle configuration is formed in the interior of the electrode pad section 4. You may be a square shape-like in addition to a circle configuration. You may prepare the non-pad section of various configurations in an edge still as mentioned above.

[0055] The operation gestalt in the configuration of the edge electrode 15 of the piece 6 of crystal in the case of carrying out support fixation on both sides as furthermore shown in drawing 1 is explained using drawing 11 , drawing 12 , and drawing 13 . Drawing 11 shows the operation gestalt of the electrode configuration which it has in the piece of crystal in the case of carrying out support fixation on both sides. The excitation electrode 14 is formed in the front reverse side, and is derived as an edge electrode 15 right and left, respectively. The configuration of the edge electrode 15 forms the non-polar zone 17 which consists of a square shape in the edge of the edge electrode 15. In drawing 11 , although the non-polar zone 17 is a single individual, plurality is sufficient as it.

[0056] Drawing 12 shows the gestalt of the operation which forms two or more non-polar zone 17 which consists of the shape of a triangle, and the gestalt of the operation which forms two or more non-polar zone 17 which becomes since drawing 13 is circular is shown. Although the gestalt of operation of this invention has indicated that it is circular, you may be a semicircle in this way and what has curvature further can be applied. Moreover, although the non-polar zone 17 has established two or more same configurations, it is good as for plurality by combining a configuration of a different kind. Moreover, as shown in drawing 5 , a configuration which becomes alternately with right and left is sufficient as the configuration of the non-polar zone 17.

[0057] As mentioned above, although the electrode pad section configuration prepared in terminal area material and the edge electrode configuration prepared in the piece of crystal were explained, the place made into the purpose is making the rate of change of the frequency in a drop test reduction-ize. The point is explained using drawing 14 and drawing 19 .

[0058] Drawing 14 is the 1 combination showing the gestalt of the operation in this invention, and is the cross section showing the portion which carries out support fixation of the piece of crystal in an electroconductive glue in terminal area material. The configuration of the electrode pad section 4 shown in drawing 7 is used for the electrode pad section of terminal area material. Furthermore, the piece 6 of crystal has adopted the configuration of the edge electrode 15 shown in drawing 4 .

[0059] Further, the electrode pad section 4 and the non-pad section 16 prepare on the 2nd substrate 2, the piece 6 of crystal has the edge electrode 15 and the non-polar zone 17, and the electroconductive glue 5 which consists of a silicon system forms it among both, and it carries out electrical installation of the excitation electrode 14 to

the electrode pad section 4. According to this structure, an electroconductive glue 5 is pasted up not to mention the electrode pad section 4 and the edge electrode 15 the piece 6 of crystal of the non-polar zone 17 of the non-pad section, and directly.

[0060] If support fixation is carried out by the electroconductive glue 5 according to such structure, the adhesion force will improve. Consequently, the support fixed force of the piece 6 of crystal increases. As for the reason, gilding is carried out, as for the front face of the electrode pad 4, and the front face is smooth. For this reason, there is a point that the adhesion force is weak, according to the kind of material like the silicon of an electroconductive glue 5, and gold, and, as for the adhesion force, the point that surface roughness is small also originates. On the other hand, ceramics expose the non-pad section, much irregularity exists on the surface of ceramics a point with the sufficient adhesion force of the ceramics and silicon, and in addition to it, and the adhesion force of an electroconductive glue 5 improves by eating into the concavo-convex section.

[0061] About the piece 6 of crystal, although the quality of the materials of the excitation electrode 14 are Au, Pd, and Ag, the adhesion force with silicon is not still better like ****. However, compared with the above, silicon is excellent in the adhesion force on the front face of crystal of the non-polar zone 17.

[0062] As mentioned above, although the electroconductive glue 5 of a silicon system is taken in the adhesion force with a metal, there is no problem in electrical installation. Then, it can improve sharply by making the both sides of ceramics and crystal paste up an electroconductive glue 5 directly, and reduction-izing of the frequency rate of change by the fall shock is possible for the support fixed force of the piece 6 of crystal.

[0063] The fall impact test result by the gestalt of operation of this invention is explained using the graph of drawing 19 . Natural fall of the drop test conditions is carried out from a height of 1.5m on concrete, and the number of times of fall of a horizontal axis and a vertical axis are the rate of change of frequency. The specification of frequency rate of change is less than [plus-or-minus 1ppm]. It is a result when bar graph G applies the operation gestalt of this invention, and a result which is less than [plus-or-minus 1ppm], and bears specification also with 20 times of fall shocks is brought.

[0064] A crystal oscillator is shown in drawing 20 as an applied operation gestalt to everything but this invention. The crystal oscillator consisted of a multilayer ceramic substrate, and the wire has connected it to a semiconductor chip 18. The piece 6 of crystal is carrying out support fixation by the electroconductive glue 5 above the semiconductor chip 18. The support fixed part of the piece 6 of crystal used at this time is the same as that of the case of the surface mount type quartz resonator mentioned above, that is, the electrode pad section configuration of terminal area material and the edge electrode configuration of the piece 6 of crystal -- the gestalt of operation of this invention -- said -- if 1 is used, the fall-proof shock nature of a crystal oscillator will improve sharply

[0065]

[Effect of the Invention] According to this invention, the secular change of the frequency of a surface mount type quartz resonator itself can be made low so that clearly from the above explanation. Furthermore, very small leak can be judged by change of a crystal impedance, and the quality of a product can be judged at an early stage. Moreover, since it is a vacuum lock, a crystal impedance is low, and the large negative resistance of VCO can be taken.

[0066] Furthermore, according to this invention, the fall-proof shock nature of a surface mount type quartz resonator can improve sharply, therefore -- although the piece of crystal was fixed to the support board which consists of a metal and the shock was absorbed with the conventional technology, such a support board is unnecessary -- becoming -- the part -- it becomes possible to make it thin

[0067] If this invention is used for a crystal oscillator further again, the product of the thin shape which was excellent in fall-proof shock nature will become possible.

TECHNICAL FIELD

[The technical field to which invention belongs] About the structure of the quartz resonator which needs this invention for the frequency reference standard of mobile communication equipment especially a cellular phone, or a pager, in more detail, in-series equivalent resistance is low, and it excels in the long term stability of oscillation frequency, reflow-proof nature, and shock resistance, and is related with the highly precise surface mount type quartz resonator which moreover makes structure of small and a thin shape possible.

PRIOR ART

[Description of the Prior Art] A highly precise temperature compensated crystal oscillator (it is indicated as Following TCXO) is used for the frequency reference standard for mobile communication equipment, such as a cellular phone. TCXO is also calculated for small and a thin shape, and the surface mount type that has reflow-proof nature further from small and the thin shape of mobile communication equipment in recent years. Therefore, after it is satisfied [with the quartz resonator which is the main parts of TCXO] of a property attaining them, moreover, a surface mount type quartz resonator is needed with small and a thin shape.

[0003] The thickness-slip-vibration child of a AT cut is used for the quartz resonator for TCXO. And the vibrator

property searched for has the small frequency deviation of ordinary temperature, the temperature characteristic of frequency is excellent in a continuity, and the rate of change of the frequency in ordinary temperature neglect, elevated-temperature neglect, cold resistance, **-proof, a temperature cycle, vibration, fall, and a reflow-proof examination is less than [plus-or-minus 1ppm] further.

[0004] Thus, process conditions need a package, selection of a closure means, crystallographic-axis selection of the piece of crystal, the suitable design of the piece size of crystal, an electrode material, the design of a suitable electrode configuration, the piece manner of support of crystal, and to be built to satisfy a severe property and attain a surface mount type quartz resonator moreover.

[0005] The structure of the surface mount type quartz resonator in the conventional technology is explained using drawing 15 , drawing 16 , drawing 18 , and drawing 19 . Drawing 16 is a cross section in which the hermetic seal in the conventional technology shows the surface mount type quartz resonator using the seam welding means.

[0006] As shown in drawing 16 , the 1st substrate 1, 2nd substrate 2, and 3rd substrate 3 constitute an alumina from a multilayer ceramic substrate made into a principal component. The electrode pad section 4 on the 2nd substrate 2 calcinated a tungsten or molybdenum, performed nickel plating on it, and has plated with gold on this nickel plating further. Support fixation of the piece 6 of crystal is carried out at one side by the electroconductive glue 5, and electrical installation is performed in this electrode pad section 4 simultaneously with support fixation.

[0007] The seam ring 7 which becomes the 3rd substrate 3 from a covar alloy is carrying out silver low attachment, performed nickel plating, and has plated with gold on this nickel plating further. Furthermore, the welding electrode 9 of a parallel seam welding machine performs a hermetic seal for the lid 8 which nickel plating gave on it at the covar alloy, and atmosphere in the container is used as the low nitrogen of a dew-point.

[0008] A pressure is atmospheric pressure although this surface mount type quartz resonator makes the inside of a container nitrogen atmosphere in order to press down the secular change of frequency low. For this reason, the crystal impedance of a quartz resonator is 13ohms - about 15ohms. Since the hermetic seal by this parallel seam welding is low-temperature junction, it does not have the heat-resistant problem of an electroconductive glue 5, and the width of face of selection has a latus advantage.

EFFECT OF THE INVENTION

[Effect of the Invention] According to this invention, the secular change of the frequency of a surface mount type quartz resonator itself can be made low so that clearly from the above explanation. Furthermore, very small leak can be judged by change of a crystal impedance, and the quality of a product can be judged at an early stage. Moreover, since it is a vacuum lock, a crystal impedance is low, and the large negative resistance of VCO can be taken.

[0066] Furthermore, according to this invention, the fall-proof shock nature of a surface mount type quartz resonator can improve sharply. therefore -- although the piece of crystal was fixed to the support board which consists of a metal and the shock was absorbed with the conventional technology, such a support board is unnecessary -- becoming -- the part -- it becomes possible to make it thin

[0067] If this invention is used for a crystal oscillator further again, the product of the thin shape which was excellent in fall-proof shock nature will become possible.

TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, there are the following troubles in the conventional surface mount type quartz resonator mentioned above. Drawing 18 is a graph which shows the secular change of the frequency in the surface mount type quartz resonator which carried out the hermetic seal with parallel seam welding in nitrogen atmosphere. A horizontal axis is the days which measured frequency from immediately after the hermetic seal, and a vertical axis is the rate of change of frequency. The frequency rate of change for [it asks] one year is less than [plus-or-minus 1ppm].

[0010] Although Curve D goes into the specification whose frequency rate of change is the above-mentioned plus-or-minus 1ppm, what frequency shifts to plus or minus with change of time like Curve A and Curve B occurs. Thus, the early judging of a quality is difficult at the time of shipment, and it cannot continue at a long period of time, and measurement cannot carry out total, either, but the product which time requires for stabilization of frequency, consequently separates from specification has the problem which appears on the market in a commercial scene.

[0011] The trouble of the surface mount type quartz resonator in the conventional technology is further explained below using the plan of drawing 15 , and the graph of drawing 19 . Drawing 15 is a plan about the state where the electroconductive glue 5 in a surface mount type quartz resonator was formed. An electroconductive glue 5 is formed as an object for support fixation of the piece 6 of crystal on the electrode pad section 4. Since the piece 6 of crystal is support fixation of one side, it makes the field of the electrode pad section 4 2 terminal structures.

[0012] The drop test result of the surface mount type quartz resonator using this means is explained using the graph of drawing 19 . Natural fall of the drop test conditions is carried out from a height of 1.5m on concrete, a horizontal axis shows the number of times of fall, and a vertical axis shows the rate of change of frequency. The

specification of a surface mount type quartz resonator is less than [plus-or-minus 1ppm] as mentioned above. It is as a result of [of the surface mount type quartz resonator which bar graph F shown by hatching explained using drawing 15 and drawing 16] a drop test.

[0013] As the graph of drawing 19 shows, the rate of change of frequency has secured less than [plus-or-minus 1ppm] to ten drop tests. However, in 20 drop tests, plus-or-minus 1ppm will be exceeded greatly. This cause is explained using drawing 15 . Gilding is given to the electrode pad section 4 and the electroconductive glue 5 of a silicon system is formed on it. However, the adhesion force of the silicon which is an electroconductive glue 5, and the gold of the electrode putt section 4 is a low. By 20 drop tests, an ablation phenomenon arises from this in both interface.

[0014] Then, the purpose of this invention is to solve the above-mentioned technical problem and offer the surface mount type quartz resonator which attained early stabilization of the secular change of frequency, and certain-ization of the quality judging by it. It aims at furthermore offering the surface mount type quartz resonator in eye in addition of the above-mentioned invention which can attain reduction-ization of the frequency rate of change in a drop test.

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(71)出願人　000001960
シチズン時計株式会社
東京都新宿区西新宿２丁目１番１号

(72)発明者　木崎　茂
埼玉県所沢市大字下富字武野840番地　シチズン時計株式会社技術研究所内

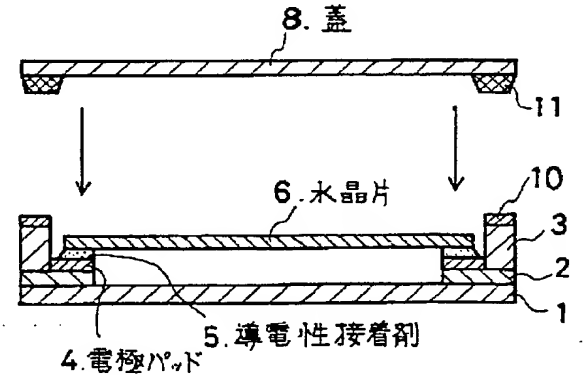
(72)発明者　坂口　能一
埼玉県所沢市大字下富字武野840番地　シチズン時計株式会社技術研究所内

(72)発明者　木村　八郎
埼玉県所沢市大字下富字武野840番地　シチズン時計株式会社技術研究所内

最終頁に続く

(54)【発明の名称】　表面実装型水晶振動子

(57)【要約】
【課題】　周波数の経年変化の早期安定化とそれによる良否判定の確実化を図った表面実装型水晶振動子を提供し、さらに落下試験における周波数変化率の低減化を図ることが可能な表面実装型水晶振動子を提供すること。
【解決手段】　端子部材の平面上あるいは凹部内に、矩形状の水晶片６に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤５により支持固定し、端子部材に蓋８を無機材料により気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空とする。



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【特許請求の範囲】

【請求項１】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋を無機材料により気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項２】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項３】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項４】　端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＺ′軸とし、それに直交したＸ軸方向である両短辺部をシリコン系、またはウレタン系の導電性接着剤により支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項５】　端子部材の平面上あるいは凹部内に、ＡＴカット矩形状水晶片の長辺方向をＺ′軸とし、それに直交したＸ軸方向である両短辺部をシリのコン系、またはウレタン系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合して容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項６】　端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＸ軸とし、それに直交したＺ′軸方向である短辺部の片側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項７】　端子部材の平面上あるいは凹部内に、Ａ

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Ｔカット矩形状の水晶片の長辺方向をＸ軸とし、それに直交したＺ′軸方向である短辺部の片側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合し容器を構成する表面実装型水晶振動子であって、
容器内は真空であることを特徴とする表面実装型水晶振動子。

【請求項８】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に有する水晶片支持固定部の電極パッド部の形状は電極パッド部内に角形または円形の非パッド部を設けるかあるいは電極パッド部の端部に角形または円形の非パッド部を有する表面実装型水晶振動子であって、
導電性接着剤は電極パッド部と非パッド部の双方に設けることを特徴とする表面実装型水晶振動子。

【請求項９】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に有する水晶片支持固定部の電極パッド部の形状は電極パッド部内に角形または円形の非パッドを設けるあるいは電極パッド部の端部に角形または円形の非パッドを有する表面実装型水晶振動子であって、
導電性接着剤は電極パッド部と非パッド部の双方に設けるすることを特徴とする請求項１、２、３、４、５、６、または７記載の表面実装型水晶振動子。

【請求項１０】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、ポリイミド系の導電性接着剤により支持固定し、端子部材の電極パッド部に固定する矩形状水晶片の端部電極の形状は、端部電極内に角形または円形の非電極部を設けるあるいは端部電極の端部に角形または円形の非電極部を設ける表面実装型水晶振動子であって、
導電性接着剤は端部電極と非電極部の双方に設けるすることを特徴とする表面実装型水晶振動子。

【請求項１１】　端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側を、シリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材の電極パッド部に固定する矩形状水晶片の端部電極の形状は、端部電極内に角形または円形の非電極部を設けるあるいは端部電極の端部に角形または円形の非電極部を設ける表面実装型水晶振動子であって、
導電性接着剤は端部電極と非電極部の双方に設けるすることを特徴とする請求項１、２、３、４、５、６、７、または８記載の表面実装型水晶振動子。

【請求項１２】　容器を構成する端子部材の材質は、セ

ラミックス、ガラスセラミックス、またはガラスからなることを特徴とする請求項１、２、３、４、５、６、７、８、９、１０、または１１記載の表面実装型水晶振動子。

【請求項１３】　容器を構成する蓋の材質は、セラミックス、ガラスセラミックス、ガラス、または金属からなることを特徴とする請求項１、２、３、４、５、６、７、８、９、１０、または１１記載の表面実装型水晶振動子。

【請求項１４】　容器を構成する蓋の材質は金属からなり、金属上に形成するめっき材料は金、パラジウム、またはニッケルとパラジウムからなることを特徴とする請求項１、２、３、４、５、６、７、８、９、１０、または１１記載の表面実装型水晶振動子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は移動体通信機器とくに携帯電話やベジャーの周波数基準源に必要な水晶振動子の構造に関するものであり、さらに詳しくは直列等価抵抗が低く、発振周波数の長期安定性と耐リフロー性と耐衝撃性に優れ、しかも小型・薄型の構造を可能とする高精度な表面実装型水晶振動子に関するものである。

【０００２】

【従来の技術】携帯電話などの移動体通信機器用の周波数基準源には、高精度な温度補償型水晶発振器（以下ＴＣＸＯと記載する）が用いられる。近年は移動体通信機器の小型・薄型からＴＣＸＯも小型・薄型、さらに耐リフロー性のある表面実装型が求められる。したがって、それらを達成するにはＴＣＸＯの主要部品である水晶振動子にも特性を満足した上で、小型・薄型でしかも表面実装型水晶振動子が必要となる。

【０００３】ＴＣＸＯ用水晶振動子には、ＡＴカットの厚み滑り振動子を用いる。そして、求められる振動子特性は、常温の周波数偏差が小さく、周波数の温度特性は連続性に優れ、さらに常温放置と高温放置と耐寒性と耐湿と温度サイクルと振動と落下と耐リフロー試験とにおける周波数の変化率は、プラスマイナス１ｐｐｍ以内である。

【０００４】このように厳しい特性を満足し、しかも表面実装型水晶振動子を達成するにはパッケージと封止手段の選択と水晶片の結晶軸選択と水晶片寸法の適切な設計と電極材料と適切な電極形状の設計と水晶片支持方法とプロセス条件の構築とが必要である。

【０００５】従来技術における表面実装型水晶振動子の構造を、図１５と図１６と図１８と図１９を用いて説明する。図１６は従来技術における気密封止がシーム溶接手段を用いた表面実装型水晶振動子を示す断面図である。

【０００６】図１６に示すように、第１の基板１と第２の基板２と第３の基板３とはアルミナを主成分とする多

層セラミックス基板で構成する。第２の基板２上の電極パッド部４はタングステンあるいはモリブデンを焼成し、その上にニッケルメッキを施し、さらにこのニッケルメッキ上に金めっきを施している。この電極パッド部４に水晶片６を導電性接着剤５により片側で支持固定し、支持固定と同時に電気的接続を行う。

【０００７】第３の基板３にコバール合金からなるシームリング７が銀ロー付けしており、ニッケルメッキを施し、さらにこのニッケルメッキ上に金めっきを施している。さらにその上にはコバール合金にニッケルめっきが施した蓋８をパラレルシーム溶接機の溶接電極９により気密封止を行い、その容器内雰囲気は露点の低い窒素としている。

【０００８】この表面実装型水晶振動子は周波数の経年変化を低く押さえるために容器内を窒素雰囲気にしているが、圧力は大気圧である。このため、水晶振動子のクリスタルインピーダンスは１３Ω～１５Ω程度である。このパラレルシーム溶接による気密封止は低温接合であることから、導電性接着剤５の耐熱性問題が無く選択の幅が広い利点がある。

【０００９】

【発明が解決しようとする課題】しかしながら、上述した従来の表面実装型水晶振動子には、つぎのような問題点がある。図１８は窒素雰囲気中にてパラレルシーム溶接により気密封止した表面実装型水晶振動子における周波数の経年変化を示すグラフである。横軸は気密封止直後より周波数を測定した日数であり、縦軸は周波数の変化率である。求められる１年間の周波数変化率はプラスマイナス１ｐｐｍ以内である。

【００１０】曲線Ｄは周波数変化率が前述のプラスマイナス１ｐｐｍの規格に入ったものであるが、曲線Ａと曲線Ｂのように時間の変化とともに周波数がプラスあるいはマイナスにシフトするものが発生する。このように周波数の安定化に時間が要し、その結果、規格をはずれる製品は、出荷時に良否の早期判定が困難であり、また全数を長期間に亘って測定もすることもできず、市場に出回ってしまう問題がある。

【００１１】つぎに図１５の平面図と図１９のグラフを使用してさらに従来技術における表面実装型水晶振動子の問題点を説明する。図１５は表面実装型水晶振動子における導電性接着剤５を形成した状態を平面図である。電極パッド部４上に水晶片６の支持固定用として導電性接着剤５を形成する。水晶片６は片側の支持固定であるため、電極パッド部４の領域は２端子構造としている。

【００１２】この手段を用いた表面実装型水晶振動子の落下試験結果を、図１９のグラフを用いて説明する。落下試験条件はコンクリート上に１．５ｍの高さから自然落下させるもので、横軸が落下の回数を示し、縦軸が周波数の変化率を示す。表面実装型水晶振動子の規格は、前述のようにプラスマイナス１ｐｐｍ以内である。ハッ

チングで示した棒グラフFが図１５と図１６を用いて説明した表面実装型水晶振動子の落下試験結果である。

【００１３】図１９のグラフで示すように、１０回の落下試験までは周波数の変化率がプラスマイナス１ｐｐｍ以内を確保している。しかしながら２０回の落下試験ではプラスマイナス１ｐｐｍを大きく越えてしまう。この原因を図１５を用いて説明する。電極パッド部４には金めっきが施されており、その上にシリコン系の導電性接着剤５が形成されている。しかし、導電性接着剤５であるシリコンと電極パット部４の金との密着力が低い。このことから、２０回の落下試験では両者の界面で剥離現象が生じる。

【００１４】そこで本発明の目的は、上記課題を解決して、周波数の経年変化の早期安定化とそれによる良否判定の確実化を図った表面実装型水晶振動子を提供することにある。さらに前述の発明の目的に加えて、落下試験における周波数変化率の低減化を図ることが可能な表面実装型水晶振動子を提供することを目的とする。

【００１５】

【課題を解決するための手段】上記目的を達成するため本発明の表面実装型水晶振動子においては、下記記載の構成を採用する。

【００１６】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋を無機材料により気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００１７】本発明の表面実装型水晶振動子は、端子部材の平面上あるいは凹部内に矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００１８】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００１９】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＺ′軸とし、それに直交したＸ軸方向である両短辺部をシリコン系、またはウレタン系の導電性接着剤により支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００２０】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＺ′軸とし、それに直交したＸ軸方向である両短辺部をシリコン系、またはウレタン系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合して容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００２１】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＸ軸とし、それに直交したＺ′軸方向である短辺部の片側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤によって支持固定し、端子部材に蓋をハンダにより気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００２２】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、ＡＴカット矩形状の水晶片の長辺方向をＸ軸とし、それに直交したＺ′軸方向である短辺部の片側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に蓋をシーム溶接により気密接合し容器を構成する表面実装型水晶振動子であって、容器内は真空であることを特徴とする。

【００２３】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、またはポリイミド系の導電性接着剤により支持固定し、端子部材に有する水晶片支持固定部の電極パッド部の形状は電極パッド部内に角形または円形の非パッド部を設けるかあるいは電極パッド部の端部に角形または円形の非パッド部を有する表面実装型水晶振動子であって、導電性接着剤は電極パッド部と非パッド部の双方に設けることを特徴とする。

【００２４】本発明の表面実装型水晶振動子においては、端子部材の平面上あるいは凹部内に、矩形状の水晶片に有する両短辺部の片側もしくは両側をシリコン系、ウレタン系、ポリイミド系の導電性接着剤により支持固定し、端子部材の電極パッド部に固定する矩形状水晶片の端部電極の形状は、端部電極内に角形または円形の非電極部を設けるかあるいは端部電極の端部に角形または円形の非電極部を設ける表面実装型水晶振動子であって、導電性接着剤は端部電極と非電極部の双方に設けることを特徴とする。

【００２５】本発明の表面実装型水晶振動子においては、容器を構成する端子部材の材質はセラミックス、ガラスセラミックス、またはガラスからなることを特徴とする。

【００２６】本発明の表面実装型水晶振動子では、容器を構成する蓋の材質は、セラミックス、ガラスセラミッ

クス、ガラス、または金属からなることを特徴とする。

【００２７】本発明の表面実装型水晶振動子においては、容器を構成する蓋の材質は金属からなり、金属上に形成するめっき材料は金、パラジウム、またはニッケルとパラジウムからなることを特徴とする。

【００２８】このように本発明の表面実装型水晶振動子は、上記の構成を採用し、本発明は従来技術の問題点をつぎの視点から改良している。すなわち周波数の早期安定化と良否判定の確実化の目的に対しては、主たる解決手段は従来技術である大気圧の窒素雰囲気中にて気密接合する構成から真空封止を採用することにより、早期安定化と良否判定の確実化を図る。

【００２９】つまり大気圧である場合は窒素雰囲気中で気密接合を行っても、シーム溶接時に発生するガスが容器内に充満し雰囲気の安定化に時間がかかる。さらに、シーム溶接時に飛散する金属の微粒子が水晶片に不安定な状態で付着することにより周波数の安定化が損なわれる。それらが複合した結果、気密接合後の周波数の安定化に時間がかかると考える。

【００３０】それに対して本発明では、真空封止の場合は気密接合後の早い時期に周波数の安定化が実現できる。つまり、真空中のために気密接合による発生するガスは容器外に排出される割合が高いと考える。このため、早期に容器内の雰囲気が安定化する。その結果、本発明の表面実装型水晶振動子では周波数の安定化が早いことになる。この周波数の安定化が早い点は、出荷時の良否判定が短時間でできる効果をもたらす。

【００３１】さらに良否判定の確実化に対する点で、シーム溶接は大気圧による気密接合であるために水晶振動子のクリスタルインピーダンスは１３～１５Ωである。しかし、微少リークがあってもクリスタルインピーダンスは変化しないものの周波数は長期間経過後にシフトする。つまり、容器内に大気が時間を要して浸透するからである。そこで、ヘリウムリーク試験器で出荷時にリーク試験を実施するが、周波数の経時変化に影響する微少リークは検出できない問題がある。

【００３２】ところが本発明の真空封止によれば、クリスタルインピーダンスは５～７Ωと低くなる。その場合、微少リークがあればクリスタルインピーダンスが容器内圧力に敏感であるためにただちに増加する。このため、その増加量を判定することにより、リークの有無が判定でき、その結果、本発明の表面実装型水晶振動子では長期間経過後の周波数のシフトを早期に判定することができる。

【００３３】一方、落下試験における周波数変化率の低減化では、薄型の表面実装型水晶振動子であるため端子部材に水晶片を直接、支持固定するが、支持固定の方法は水晶片の片側と両側の２種類がある。本発明では両側の場合に軟性であるシリコン系導電性接着剤を使用し、落下衝撃による周波数シフトを低減している。つまり本発明の表面実装型水晶振動子では、導電性接着剤に弾性を有するものを使用して落下衝撃による機械的応力を緩和している。さらに導電性接着剤の弾性は水晶片に加わる機械的応力を緩和する効果から周波数の経時変化にも有効である。

【００３４】しかし軟性のシリコン系接着剤も端子部材に有する電極パッド部と水晶片に有する端部電極の金との密着力が高いとは言えない。このため、強度の落下衝撃では両者の界面で剥離現象が生じて周波数が変化する問題がある。

【００３５】ところが、シリコン系の導電性接着剤は端子部材のセラミックスと水晶とは密着力が強い現象を確認している。そこで本発明は端子部材の電極パッド部にはセラミックスも表面に露出させ、さらに水晶片の端部電極には水晶を露出させる。このことにより、シリコン系導電性接着剤は金のみでなく、セラミックスと水晶の双方に接着することにより水晶片の支持固定力を向上させて、落下衝撃による周波数の変化率を、本発明では低減したものである。

【００３６】

【発明の実施の形態】以下図面を用いて本発明を実施するための最良の形態における表面実装型水晶振動子を説明する。図１は、本発明の実施形態における水晶片を両側で支持固定して蓋を気密接合する前の状態を示す断面図である。図２は本発明の実施形態における片側を支持固定して蓋を気密接合した状態を示す断面図である。図３は本発明の図１における蓋を気密接合する前の状態を示す平面図である。図４は本発明における水晶片の結晶軸を示す平面図である。図５と図６と図７と図８と図９と図１０とは本発明の実施形態における絶縁端子部材の各種電極パッド部形状を示す平面図である。さらに図１１と図１２と図１３は本発明の実施形態における水晶片の各種端部電極形状を示す平面図である。図１４は本発明を用いた絶縁端子部材と水晶片を組み合わせて導電性接着剤で支持固定した構造を示す断面図である。図１７は本発明の実施形態における蓋を示す断面図である。図２０は水晶発振器を示す断面図である。以下本発明の実施形態を示す図面を用いて説明するが、適宜従来技術を示す図面を参照して説明する。

【００３７】図１と図３に示すように、第１の基板１と第２の基板２と第３の基板３とによって端子部材を構成する。そして水晶片６はその両端部にて端子部材に支持固定している。第１の基板１と第２の基板２と第３の基板３の多層セラミックス基板からなる端子部材に電極パッド部４と気密シール部１０をタングステンまたはモリブデンを焼成し、そのタングステンまたはモリブデン上にニッケルめっきを施しさらに金めっきを施している。

【００３８】本発明の実施形態では端子部材にアルミナを主成分としたセラミックスで説明するが、ガラスセラミックスやガラスを適用してもよい。ガラスセラミック

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スからなる端子部材の場合は、電極パッド部４と気密シール部１０の材質に銀あるいは銀とパラジウムの混合体を用いる。

【００３９】以下、本発明の形態での説明は端子部材を三層基板で説明するが、第２の基板２を削除した二層基板でも、一層基板でもよい。図１に示す電極パッド部４にはシリコン系の導電性接着剤５を形成してその上に水晶片６を設置する。導電性接着剤５はウレタン系の接着剤でもよい。つまり、軟性の接着剤ならよい。

【００４０】図１に示す蓋８にはハンダ１１を形成する。その詳細構造を図１７の断面図を使用して説明する。図１７に示す蓋の母材１２はコバールや鉄ニッケル合金からなり、そのコバールや鉄ニッケル合金上に表面処理膜１３としてニッケル被膜と金被膜との２層構造、あるいはニッケル被膜とパラジウム被膜との２層構造、あるいはニッケル被膜とニッケルパラジウム被膜との２層構造を採用する。

【００４１】このニッケル被膜は耐食性向上の役割をもち、金被膜やパラジウム被膜はハンダ１１との濡れ性を向上させる役割をもつ。このうちパラジウムを用いる理由はハンダ１１による食われ現象がなく気密リークが少ない特徴があるからである。またハンダ１１の材質は金（Ａｕ）－スズ（Ｓｎ）や、鉛（Ｐｂ）－銀（Ａｇ）－スズ（Ｓｎ）や、鉛（Ｐｂ）－スズ（Ｓｎ）などの合金を用いる。上記以外に気密封止が可能な低温材料であるならばハンダ１１として適用可能である。

【００４２】さらに蓋８の材質としては金属材料で説明したが、セラミックスやガラスセラミックスやガラスも適用可能である。端子部材と蓋８とは、その熱膨張係数が整合する組み合わせが好ましい。

【００４３】図１では第３の基板３に形成している気密シール部１０に蓋８のハンダ１１を真空中にて溶着している。ハンダ１１が金（Ａｕ）－スズ（Ｓｎ）であれば溶着温度は３００℃前後であり、溶着時間は数分である。また、多数個処理できるヒーター基板にて溶着作業を行う。

【００４４】図２に示す実施形態は、図１に示す構造とほとんど同じ構成であるが水晶片６の支持固定を片側で行う。その片側支持の端子部材に有する電極パッド部４は図９に示すように片側を２端子にする。さらに、導電性接着剤５はシリコン系でもよいがポリイミド系でもよい。水晶片６の支持固定を片側にしたことによって、支持固定力を高めるためにシリコン系よりやや硬い材質を用いるものである。

【００４５】図１と図２と図３を使用して説明した本発明の形態における表面実装型水晶振動子の周波数の経年変化を図１８に示すグラフで説明する。横軸は気密封止直後より周波数を測定した日数であり、縦軸は周波数の変化率である。求められる１年間の周波数変化率はプラスマイナス１ｐｐｍ以内である。

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【００４６】従来のシーム溶接にて大気圧の窒素雰囲気中で気密封止した表面実装型水晶振動子は曲線Ａと曲線Ｂと曲線Ｄに示すように周波数の安定化に時間が要していたが、本発明による表面実装型水晶振動子は曲線Ｃに示すように早期に周波数が安定するとともに長期間における周波数の変化率は小さくなっている。さらに不良品は曲線Ｅに示すように短期間に大きく劣化する。すなわち、従来の大気圧封止に比べて良否が短期間のうちにはっきりする。このため、出荷時に良否判定を早い時期に下すことができる。

【００４７】本発明の実施形態による表面実装型水晶振動子はつぎの組み合わせから周波数の早期安定化と長期間における周波数の変化率を小さくしている。すなわち容器内を真空にすることで気密封止時の発生ガスを少なくしている。また図２と図３に示すように水晶片６を両側で支持固定した場合は軟性のシリコン系の導電性接着剤５を用いて水晶片６に加わる機械的応力を緩和させている。水晶片６と端子部材のセラミックスでは熱膨張係数が異なるからである。

【００４８】さらに図４に示すように、水晶片６を両側で支持固定する実施形態では水晶片６の長辺方向をＺ´軸とし、それに直交するＸ軸からなる両端辺部１５を導電性接着剤５で支持固定している。つまり水晶片６に設ける励振電極１４にて振動する厚み滑り振動の振動波はＸ軸方向に伝搬し、Ｚ´軸への伝搬は小さい点を考慮してＺ´軸方向を支持固定することで厚み滑り振動への影響を小さくした点である。

【００４９】一方、前述とは逆に図２に示す片側にて水晶片６を支持固定する場合は、図４に示す結晶軸を逆にする。つまり、長辺方向をＸ軸とし短辺部をＺ´とする。片側支持の場合は２端子となり、図９に示すように２箇所の電極パッド部４に水晶片６を導電性接着剤５で支持固定するが、上述のごとく厚み滑り振動の振動波はＺ´軸方向に小さいためである。したがってポリイミド系のようにシリコン系よりやや硬い導電性接着剤５でも、同様に周波数の安定化が図れる。

【００５０】本発明における実施の形態をハンダ封止にて説明してきたが、図１６に示す従来技術のシーム溶接法であっても、真空封止であって、軟性の導電性接着剤を用い、かつ支持固定法は水晶片の結晶軸方向を考慮した組み合わせを用いれば、本発明で説明したものと同様の効果が得られる。シーム溶接法も溶接時のスパークによりガスが発生するが真空排気しながら気密接合すれば、容器内のガスは少なく、周波数の安定化を図ることができる。

【００５１】つぎに落下試験による周波数変化率の低減化に対する本発明の実施の形態を図面を使用して説明する。図１において、電極パッド部４に導電性接着剤５を形成し、水晶片６が支持固定されているが本発明における電極パッド部４の形状を順次説明する。図５は第２の

基板２上の電極パッド部４の端部に角形を有する非パッド部１６を左右交互に複数個設ける実施形態を示す。図５では角形を用いているが円形であってもよい。導電性接着剤５は電極パッド部４と非パッド部１６の双方に設ける。

【００５２】図６は電極パッド部４の端部に角形を有する非パッド部１６を単個設ける実施形態を示す。非パッド部１６は第２の基板２と同一のセラミックスである。非パッド部１６を端子部材の右側に有しているが左側でもよい。この図６に示す実施形態の場合も、導電性接着剤５は電極パッド部４と非パッド部１６の双方に設ける。

【００５３】図７は電極パッド部４の内部に角形状の非パッド部１６を設ける実施形態を示す。非パッド部１６は角形状以外に円形状などでもよく、複数個設けてもよい。図８は電極パッド部４の端部に三角形状を有する非パッド部１６を複数個設ける実施形態を示し、図９は円形状を有する非パッド部１６を複数個設ける実施形態を示す。本発明の実施の形態では円形と記載しているが、このように半円であってもよく、さらに曲率を有するものも適用可能である。また、同一形状を複数個設けているが異種形状の組み合わせでもよい。いずれも導電性接着剤５は電極パッド部４と非パッド部１６の双方に亘って設ける。そして、電極パッド部４と非パッド部１６との面積割合はおよそ１対１が好ましい。

【００５４】図１０は図２に示すような水晶片６を片側で支持固定する場合の電極パッド部形状の実施形態を示す。片側で支持固定する場合の水晶片６の電極は片側に２端子となるために電極パッド部も片側に２端子を設けている。電極パッド部４の内部に円形状からなる非パッド部１６を設けている。円形状以外に角形状であってもよい。さらに前述のように端部に各種形状の非パッド部を設けてもよい。

【００５５】さらに図１に示すような両側で支持固定する場合の水晶片６の端部電極１５の形状における実施形態は図１１と図１２と図１３を使用して説明する。図１１は両側で支持固定する場合における水晶片に有する電極形状の実施形態を示す。励振電極１４は表裏に形成されそれぞれ左右に端部電極１５として導出する。その端部電極１５の形状は端部電極１５の端部に角形からなる非電極部１７を設けるものである。非電極部１７は図１１では単個であるが複数個でもよい。

【００５６】図１２は三角形状からなる非電極部１７を複数個設ける実施の形態を示し、図１３は円形からなる非電極部１７を複数個設ける実施の形態を示す。本発明の実施の形態では円形と記載しているが、このように半円であってもよく、さらに曲率を有するものも適用可能である。また非電極部１７は、同一形状を複数個設けているが、異種の形状を組み合わせることで複数個にしてもよい。また、図５に示すように非電極部１７の形状は

左右交互になるような形状でもよい。

【００５７】前述のように、端子部材に設ける電極パッド部形状と水晶片に設ける端部電極形状について説明したが、その目的とするところは落下試験における周波数の変化率を低減化させることである。その点について図１４と図１９を用いて説明する。

【００５８】図１４は本発明における実施の形態を表す一組み合わせであり、端子部材に水晶片を導電性接着剤にて支持固定する部分を示す断面図である。端子部材の電極パッド部には図７に示す電極パッド部４の形状を用いている。さらに水晶片６は図４に示す端部電極１５の形状を採用している。

【００５９】第２の基板２上に電極パッド部４と非パッド部１６が設け、さらに水晶片６は端部電極１５と非電極部１７を有し、シリコン系からなる導電性接着剤５が両者の間に形成し、励振電極１４は電極パッド部４に電気的接続する。この構造によれば導電性接着剤５は、電極パッド部４と端部電極１５はもちろんのこと、非パッド部の非電極部１７の水晶片６と直接接着される。

【００６０】このような構造により導電性接着剤５にて支持固定すると密着力が向上する。その結果、水晶片６の支持固定力が増大する。その理由は、電極パッド４の表面は金めっきがされており、表面は平滑になっている。このため、導電性接着剤５のシリコンと金のように材料の種類により密着力が弱い点もあるが、密着力は表面粗さが小さい点も起因する。一方、非パッド部はセラミックスが露出し、そのセラミックスとシリコンとの密着力がよい点とそれ以外にセラミックスの表面には凹凸が多数存在し導電性接着剤５はその凹凸部に食い込むことで密着力が向上する。

【００６１】さらに水晶片６については励振電極１４の材質がＡｕ、Ｐｄ、Ａｇであったりするがシリコンとの密着力は上述と同様によくない。しかし、前記に比べてシリコンは非電極部１７の水晶表面との密着力が優れる。

【００６２】前述のように、シリコン系の導電性接着剤５は金属との密着力におとるが、電気的接続には問題がない。そこで、水晶片６の支持固定力は導電性接着剤５をセラミックスと水晶の双方に直接接着させることで大幅に改善でき、落下衝撃による周波数変化率の低減化が可能である。

【００６３】本発明の実施の形態による落下衝撃試験結果を図１９のグラフを使用して説明する。落下試験条件はコンクリート上に１．５ｍの高さから自然落下させるもので、横軸が落下の回数、縦軸が周波数の変化率である。周波数変化率の規格はプラスマイナス１ｐｐｍ以内である。棒グラフＧが本発明の実施形態を適用したときの結果であり、２０回の落下衝撃でもプラスマイナス１ｐｐｍ以内であり規格に耐える結果となっている。

【００６４】本発明の他への応用した実施形態として図

２０に水晶発振器を示す。水晶発振器は多層セラミックス基板からなり、半導体チップ１８にワイヤーが接続している。その半導体チップ１８の上方に水晶片６が導電性接着剤５にて支持固定している。このときに用いる水晶片６の支持固定部は上述した表面実装型水晶振動子の場合と同一である。つまり、端子部材の電極パッド部形状と水晶片６の端部電極形状は本発明の実施の形態と同一を用いれば水晶発振器の耐落下衝撃性は大幅に向上する。

【００６５】

【発明の効果】以上の説明から明らかなように、本発明によれば表面実装型水晶振動子の周波数の経年変化自身を低くすることができる。さらに、クリスタルインピーダンスの変化で微少リークが判定でき、早期に製品の良否を判定できる。また、真空封止であることからクリスタルインピーダンスが低く、発振器の負性抵抗が大きくとれる。

【００６６】さらに本発明によれば表面実装型水晶振動子の耐落下衝撃性が大幅に向上することができる。したがって従来技術では水晶片を金属からなるサポート板に固定し衝撃を吸収していたが、そのようなサポート板は不要となりその分薄くすることが可能となる。

【００６７】さらにまた本発明を水晶発振器に用いれば、耐落下衝撃性の優れた薄型の製品が可能となる。

【図面の簡単な説明】

【図１】本発明の実施形態における表面実装型水晶振動子の構造を示す断面図である。

【図２】本発明の実施形態における表面実装型水晶振動子の構造を示す断面図である。

【図３】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図４】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図５】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図６】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図７】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図８】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図９】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図１０】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図１１】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図１２】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図１３】本発明の実施形態における表面実装型水晶振動子の構造を示す平面図である。

【図１４】本発明の実施形態における表面実装型水晶振動子の構造を示す断面図である。

【図１５】従来技術における表面実装型水晶振動子の構造を示す平面図である。

【図１６】従来技術における表面実装型水晶振動子の構造を示す断面図である。

【図１７】本発明の実施形態における表面実装型水晶振動子の構造を示す断面図である。

【図１８】表面実装型水晶振動子における周波数の経年変化を示すグラフである。

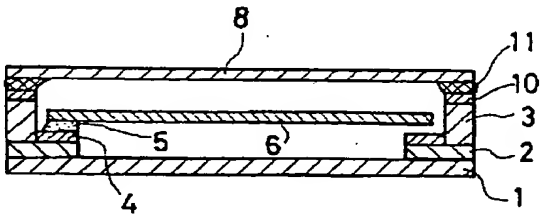
【図１９】表面実装型水晶振動子の落下試験結果を示すグラフである。

【図２０】本発明の実施形態における表面実装型水晶振動子の構造を示す断面図である。

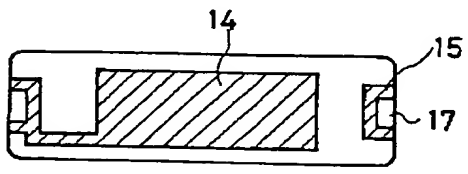
【符号の説明】

１　第１の基板
２　第２の基板
３　第３の基板
４　電極パッド部
５　導電性接着剤
６　水晶片
８　蓋
１０　気密シール部
１１　ハンダ
１２　母材
１４　励振電極
１５　端部電極
１６　非パッド部
１７　非電極部
１８　半導体チップ

【図２】



【図１１】



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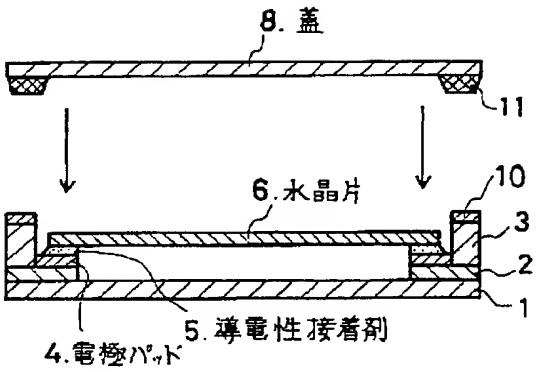

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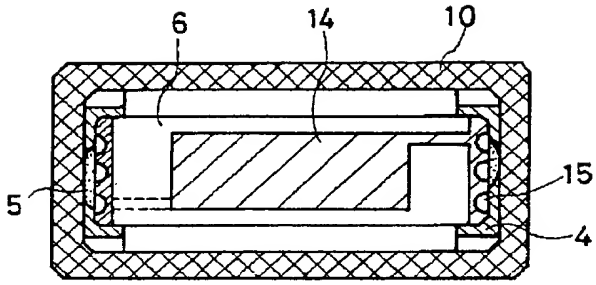
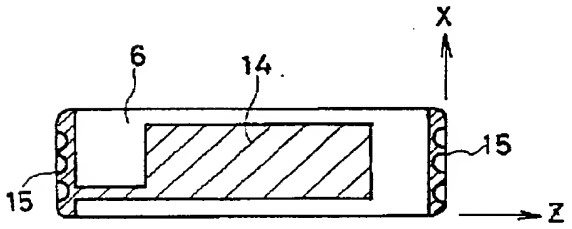


【図６】

【図４】



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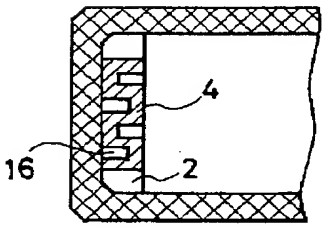
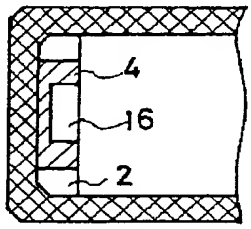
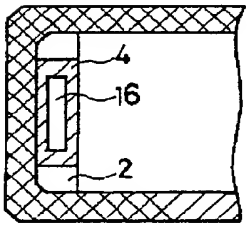




【図１０】

【図７】



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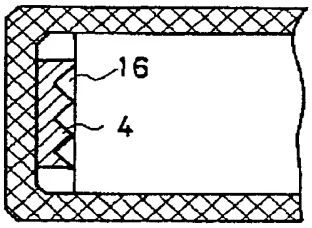

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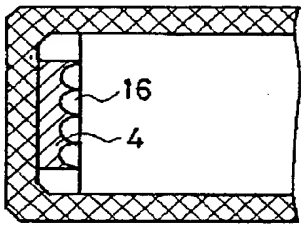
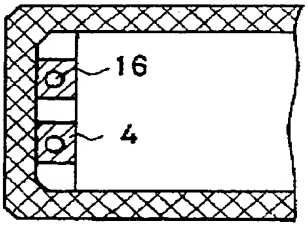
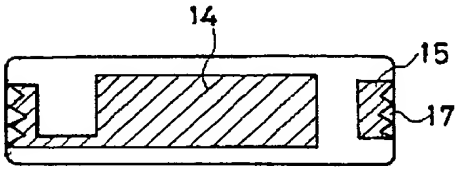




【図１５】

【図１２】



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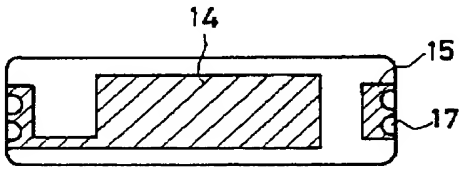

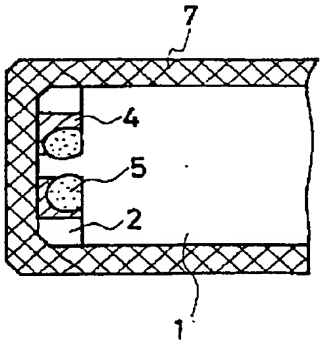

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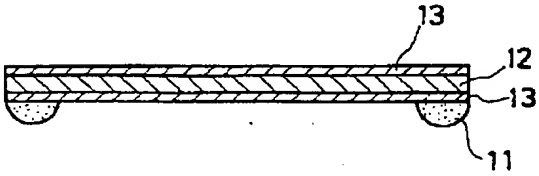

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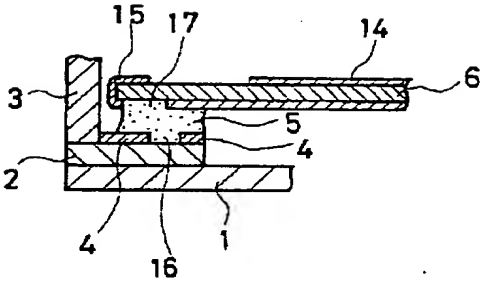

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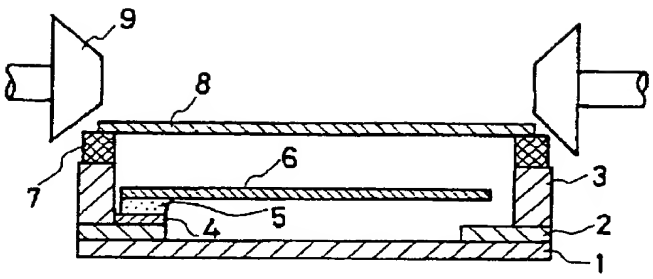

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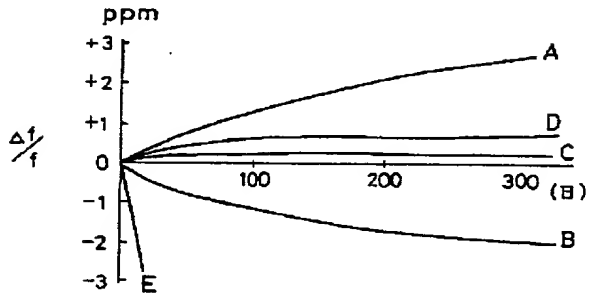

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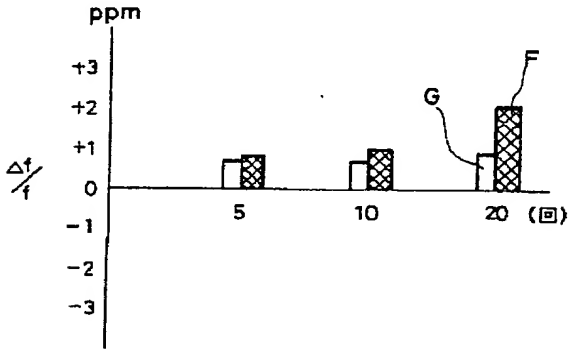

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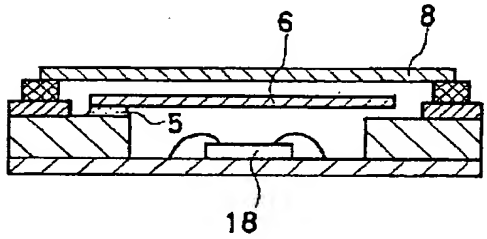

フロントページの続き

(72)発明者　村田　一男
埼玉県所沢市大字下富字武野840番地　シチズン時計株式会社技術研究所内
(72)発明者　中山　一誠
埼玉県所沢市大字下富字武野840番地　シチズン時計株式会社技術研究所内
(72)発明者　田中　隆昌
長野県北佐久郡御代田町大字御代田4107番地５　ミヨタ株式会社内
(72)発明者　大井　俊英
長野県北佐久郡御代田町大字御代田4107番地５　ミヨタ株式会社内